

thanks

L'exemplaire filmé fut reproduit grâce à la
générosité de:

Bibliothèque
Agriculture Canada

ality
bility
e

Les images suivantes ont été reproduites avec le
plus grand soin, compte tenu de la condition et
de la netteté de l'exemplaire filmé, et en
conformité avec les conditions du contrat de
filimage.

filmed
on
mpres-
All
on the
es-
nted

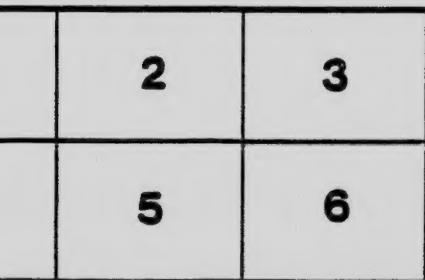
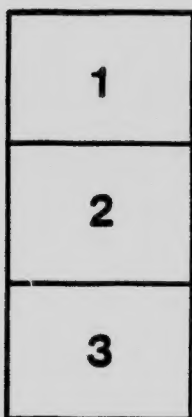
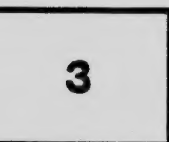
Les exemplaires originaux dont la couverture en
papier est imprimée sont filmés en commençant
par le premier plat et en terminant soit par la
dernière page qui comporte une empreinte
d'impression ou d'illustration, soit par le second
plat, selon le cas. Tous les autres exemplaires
originaux sont filmés en commençant par la
première page qui comporte une empreinte
d'impression ou d'illustration et en terminant par
la dernière page qui comporte une telle
empreinte.

ON-
D").

Un des symboles suivants apparaîtra sur la
dernière image de chaque microfiche, selon le
cas: le symbole ➡ signifie "A SUIVRE", le
symbole ▼ signifie "FIN".

t
o be
l
t to
s
the

Les cartes, planches, tableaux, etc., peuvent être
filmés à des taux de réduction différents.
Lorsque le document est trop grand pour être
reproduit en un seul cliché, il est filmé à partir
de l'angle supérieur gauche, de gauche à droite,
et de haut en bas, en prenant le nombre
d'images nécessaire. Les diagrammes suivants
illustrent la méthode.



DOMINION OF CANADA.
DEPARTMENT OF AGRICULTURE.
EXPERIMENTAL FARMS.

J. H. GRISDALE, B. Agr.,
Director.

FRANK T. SHUTT, M.A., D.Sc.,
Dominion Chemist.

DIVISION OF CHEMISTRY

POTASH IN AGRICULTURE

BY

FRANK T. SHUTT, M.A., D.Sc.
Dominion Chemist.

CIRCULAR No. 7.

Published by authority of Hon. MARTIN BURRELL, Minister of Agriculture, Ottawa, Ont.

OTTAWA
GOVERNMENT PRINTING BUREAU
1914.

POTASH IN AGRICULTURE.

BY

FRANK T. SHUTT, M.A., D.Sc.,

Dominion Chemist.

Among the evil effects resulting from the terrible and disastrous war now raging in Europe is to be counted the cutting off from the markets of the world of the supply of potash from the Stassfurt mines. For many years these mines have been practically the sole source of the potash compounds used for fertilizing purposes, and it is little wonder, therefore, in these days when the employment of fertilizers is ever on the increase, that this stoppage of the supply should have caused consternation.

But on looking more deeply into the matter and considering it especially from the standpoint of the Canadian farmer, we find the case is not so serious nor fraught with such dire consequences as might be imagined from the superficial view expressed by many interested in our agriculture. There is, in the opinion of the writer, very little cause for real alarm or anxiety, even if the supply from the German mines be not resumed for a year or two. There is no need to anticipate any material falling off in yields, even of those of the potash-loving crops, for although the quantity of German potash compounds used for fertilizing has been annually increasing for the past few years, the total amount used to-day in Canada is comparatively small, certainly not more than 8,000 tons per annum. Indeed this calamity, if such it may be called, will have its useful lessons, drawing attention to our home sources of potash, their use and conservation, to the crops for which potash is more particularly beneficial and lastly to those rational methods for maintaining soil fertility which put into practice, will alone render the farmer largely independent of fertilizers.

THE ROLE OF POTASH.

There is no desire on the part of the writer to disguise the fact or minimize its importance, that potash is one of the three "essential elements of fertility," the elements that have received this appellation not because they are any more essential to the growth of crops than the other nine or ten elements entering into the composition of plant tissues, but because they are the three—nitrogen, phosphoric acid and potash—which must be constantly returned to the soil if its productiveness is to be maintained under our ordinary systems of farming, and which, as we well know, entail the removal and sale of at least a portion of our crops.

But at the outset there is this consoling fact that of the three, potash is the least important from the standpoint of the necessity of application. It is "more widely distributed and less frequently deficient in soils than nitrogen and phosphoric acid." Clay loams as a rule are well supplied with potash and seldom respond profitably to an application of a special potassic fertilizer. Indeed upon heavy clays such an application may depress the yield by bringing about an unfavourable condition of tilth. It is more particularly sandy and gravelly loams, calcareous soils and soils rich in vegetable matter, as mucks and peaty loams, which are poor in potash and upon which this element may be expected to give a profitable return.

Again, it is not all crops that call for special potassic manuring. On our staple cereal crops, wheat and oats, potash seldom gives a remunerative return, save on the lightest and driest soils. Barley for malting purposes is to some degree an exception among the cereals, frequently responding profitably to potassic manures and particularly so on sandy soils.

If potassium is one of the essential elements for growth, as we have stated, it must perform certain vital functions in plant nutrition. The most important of these, it would appear, is related to and indispensable for the production of the carbohydrates—starch, sugar and cellulose—within the plants. Hence it is that crops rich in those constituents—mangels, sugar beets, potatoes, etc.—are those which are specially benefited by potassic manures. Fruits, large and small, and the leguminous plants—clover, peas, etc.—must be added to the list of those responding to potash. These are the crops, then, on sandy, gravelly loams, for which potash should be reserved, whether it be contained in a purchased fertilizer or one of the home resources, as wood ashes, seaweed, etc.

THE PRESENT SUPPLY.

It is impossible to state what quantity of German potash salts there may be at the moment in the American market, probably the stock is almost entirely in the hands of the fertilizer manufacturers, who will find it more profitable to sell it in mixed goods, that is, with nitrogen and phosphoric acid as complete fertilizers, rather than to dispose of it as the muriate and sulphate directly to the farmer. The outlook therefore, is that these latter compounds will be unattainable until such times as a fresh supply is obtained from the Stassfurt mines. But as it is stated on fairly good authority that three-eighths of the annual supply was received before the war began, it will be obvious that we are not yet entirely destitute.

The results of the cutting off of the supply will naturally lead the manufacturers to the putting out of brands with a low potash content; they will endeavour to make their stock go as far as possible. There will be brands containing two and three per cent of potash that of late years contained eight or ten per cent. These will be in a large measure comparable to those on the market twenty years ago. It has only been in quite recent years that the potash content in mixed fertilizers has been raised, in response to a demand from farmers for a larger proportion of this element, especially in brands intended for potatoes. This demand has arisen more particularly from good returns from the use of high potash fertilizers on sandy loams and soils rich in organic matter, but it is a question whether results generally, and especially on soils containing a fair amount of organic matter, warrant the large dressings of potash that have of late been used. Certain experiments conducted by the Experimental Farm system have not furnished evidence as to the profitable employment of high potassic fertilizers, on ordinary soils in a good state of cultivation.

POSSIBLE COMMERCIAL SOURCES.

Before drawing attention to the farmer's home sources of potash it may be well to attempt an answer to those inquiring if Canada has not some larger sources of potash—raw material—that could be worked commercially and thus place us in an independent position with regard to the German salts. She probably has such stores, in orthoclase feldspar and certain allied minerals, in saline deposits at greater or less depths and in the seaweeds on her coasts, but hitherto these have not been commercially exploited for the reason that the cost of extraction of their potash would not have permitted the product being placed on the open market in competition with the Stassfurt salts. And it is even now doubtful if capital could be induced to venture on the scale necessary to success, seeing that the initial stages of such an enterprise are seldom wholly successful and that the output of the German mines,

may, at almost any time, be again available. But the matter is not being overlooked. For some years past the Division of Chemistry of the Experimental Farms has had under investigation the seaweeds of the Atlantic and Pacific coasts and already the analyses of many of the more important varieties have been published. A survey of the kelp groves on the Pacific coast has been undertaken by the Biological Board of Canada with the view, among other matters, of determining the location and extent of the beds, and the probable amount of the several varieties that would be available for manufacturing purposes.

MANURE AS A SOURCE OF POTASH.

And now we come to what may be considered the main purpose of this bulletin—the discussion of those sources of potash available to our farmers and which if recognized and used will render us largely independent of the German salts. First we have the farm manures. These are not usually thought of as a source of potash, much to our national loss. We are quite safe in saying that thousands of tons of potash from this source are annually wasted in Canada. With certain minor exceptions, as in the wool of sheep and the milk of dairy cows, practically all the potash in the feeds and fodders consumed by our farm stock is excreted by the kidneys. More than ninety per cent of the total potash excreted by the animal is to be found in the urine, and this in addition to the fact that one-half or more of the total nitrogen excreted is also present in the liquid excreta. It thus comes about that weight for weight, urine has a greater manurial value than the solid excrement, and this not only by reason of its larger percentages of potash and nitrogen, but because these constituents are in a soluble condition and practically at once available for the nutrition of crops. To support these statements we append the following data, giving the average composition of the solid and liquid excreta of our farm stock.

COMPOSITION OF URINE AND SOLID EXCRETA.

Animal.	Excreta.	Water.	Nitrogen.	Phosphoric Acid.	Potash.
Horse	Solid ..	75.0	.56	.35	.1
	Liquid	90.0	1.52	trace.	.92
Cow	Solid	86.0	.44	.12	.04
	Liquid	91.5	1.05	trace.	1.36
Sheep ..	Solid	87.6	.72	.44	.3
	Liquid	86.5	1.31	.01	2.0
Pig	Solid	76.0	.48	.58	.36
	Liquid	97.6	.50	.14	.70

We have stated that practically all the potash in the foods is excreted by the animal. To illustrate this fact the following results of an experiment conducted at the Rothamsted Experimental Station may be given.

POTASH RETAINED AND EXCRETED.

—	In 100 lbs Oil Cake.	Fattening Steers.			Milch Cows.		
		In Meat.	In Urine.	In Feces.	In Milk.	In Urine.	In Feces.
Potash	Lbs. 1.4	.02	1.10	.28	.14	1.05	.21

The evidence is therefore conclusive as to the greater richness of liquid manure in potash. To allow it to be wasted as it is on too many farms to-day is little short of a crime against the land. Its value as a nitrogenous fertilizer could be emphasized even more strongly than as a source of potash, but our chief object in this bulletin is to call attention to it as the latter. By returning it to the land practically all the potash taken out of the soil by the growth of our crops could be put back for future use. It will not be found advantageous to run off this liquid manure into cisterns for subsequent application as such to the land as is done in many European countries, owing to our rigorous winter and the high price of labour, but we must use a sufficient quantity of absorbent bedding material to hold it with the solid excrement. Straw, preferably cut short, and air-dried peat and muck are excellent absorbents and they subsequently give up their plant food to swell the amount contained in the excreta, besides giving bulk which will facilitate the more uniform distribution of the resulting manure on the land. If the temporary deprivation caused by the cutting off of the German supply of potash teaches us the value of the liquid portion of the manure, it will not be a lesson learnt too dearly.

WOOD ASHES AS A POTASSIC FERTILIZER.

The ashes of wood have long been recognized as a fertilizer of very considerable value, indeed their use in agriculture is historic. In all countries, including Canada, practising agriculture they have been highly prized, especially for clover, grapes and fruit trees and leafy crops generally, on sandy and light loams and it was only with the advent of the German potash salts that their use fell off, though, of course, their production in decreasing quantities of late years, owing to the disappearance of our forests, has been an important factor in making it more and more difficult for the farmer in the older settled districts to obtain them.

They are essentially a potassic fertilizer, ashes of good quality, that is, dry, unmixed with sand, etc., and unleached, containing between 4 per cent and 6½ per cent potash—the average potash content being about 5½ per cent. This potash is in a soluble form and hence immediately available for crop use; moreover the writer considers that it exists in these ashes in a condition (the carbonate) much more favourable for the nutrition of plants than that in the German compounds and should be worth at least 1 cent per pound more than in the latter. There is in fact no better potassic fertilizer.

In addition to their potash they contain some 2 per cent phosphoric acid and from 20 to 30 per cent carbonate of lime, enhancing their fertilizing value and making them, in a sense, an all-round fertilizer for supplying the mineral elements required by crops. And, further, to correct acidity, a condition detrimental to the thrift of most farm crops. The German potash salts are of no value for neutralizing acidity.

Naturally, genuine wood ashes are somewhat variable in composition, depending partly on the nature of the wood producing them and partly on the care with which they have been collected and stored. Wilful adulteration of a false character has been occasionally detected in commercial samples, addition of sand and other inert matter and leaching being the most common forms of adulteration.

There is a general belief that ashes from hardwoods, as a class, are richer in potash than those from soft woods but our analyses scarcely confirm this impression. As might be expected, woods differ very considerably in their potash content and the ashes of twigs and boughs are much richer than those of trunk woods. Pine and other soft woods as a rule contain less ash than the hard woods and are much lighter in character and it is this latter quality or property we think that has given rise to the common belief referred to. According to our results we cannot find that *weight for weight*, the ashes of soft wood are much, if any, poorer than those from hard woods.

Our advice in these times must, therefore, be to conserve more carefully this home source of potash, not merely collecting the ashes from the house stoves but

burning such brush piles, old roots, etc., as may result from the clearing of land, pruning of orchards, etc., and saving the resulting ashes. Storage in a shed or receptacle protected from the weather is essential to prevent deterioration.

From 25 to 50 bushels of wood ashes per acre will furnish from 60 to 120 pounds of potash, the latter an ample dressing for even very light soils. They are not needed on heavy clay loams, indeed their use on such may destroy good tilth and do more harm than good. Their application is best deferred till spring, broadcasting, preferably on a quiet damp day, on the ploughed land and incorporating with a thorough harrowing.

For clover, corn and mangels, they will be found very valuable. Especially are they beneficial for orchards and for grapes on sandy loams. For turnips, mixed with one-third to one-half their weight of bone meal, they have similarly proved advantageous. But indeed there are few crops on light and gravelly soils, as also on vegetable loams inclined to be sour, for which wood ashes cannot be employed with profit.

SEAWEED AS A POTASSIC FERTILIZER.

The use of seaweed as a fertilizer dates back to historic times and its value for the upkeep of soil fertility has been generally and practically recognized in both the old world and the new by farmers residing not too far distant from the coast line. Seaweed occurs on both our Atlantic and Pacific coasts (more abundantly probably on the latter) and may be collected in large amounts at little expense on many sea beaches, where it is thrown up by storms at times in prodigious quantities. It can also be collected in boats from rocks and from floating masses not far from the shore. There are many varieties, some are quite small, others attain large proportions, but all are valuable, though naturally differing somewhat in composition.

Seaweed is essentially a potassic fertilizer, being specially rich in potash, but it also contains notable amounts of nitrogen and other elements of plant food, so that it might be termed a complete manure.

Analyses of many Canadian seaweeds, more especially from the Atlantic seaboard, have been made in the Experimental Farm laboratory at Ottawa, and we append in tabular form certain of the data as illustrative of their general composition. This inquiry is still in progress and there are at present a considerable number of samples, collected on the Pacific coast through the kindness of the Biological Board of Canada, awaiting analysis.

ANALYSES OF SEAWEEDS COLLECTED ON THE ATLANTIC SEABOARD.

	<i>Fucus furcatus.</i>	<i>Fucus vesiculosus.</i>	<i>Ascophyllum nodosum.</i>	<i>Porphyra laciniata.</i>	<i>Laminaria longicruris.</i>
Water	63.49	88.29	75.14	79.42	88.30
Organic matter	27.93	7.61	19.30	15.15	7.15
Ash or mineral matter.	8.58	4.10	5.56	5.43	4.55
	100.00	100.00	100.00	100.00	100.00
Nitrogen	.468	.182	.273	.925	.251
Phosphoric acid.....	.198	.037	.070	.062	.134
Potash	2.025	.615	.619	.619	1.546

Fresh seaweed is undoubtedly a watery manure, and it is this fact, no doubt—the cartage being a more or less expensive feature—that limits its use to those living more or less close to the shore. A part of this useless water may be got rid of by piling the seaweed on the beach for a few days before hauling to the farm. But notwithstanding its large percentage of water, seaweed compares very favourably, weight

for weight, with barnyard manure and it has this additional value that it brings to the farm no weed seeds or insects or fungus pests.

The essentially potassic character of seaweeds is well brought out by the analyses given, but it will also be noted that they are especially rich in nitrogen. The differences in composition between the varieties may in part be accounted for by the stage of growth or maturity at the time of collection and in this connection it is interesting to note that for several varieties collections made during the winter have shown a higher potash content than samples taken in summer.

The manurial value of seaweed is greatly enhanced by its ready decomposition in the soil; it quickly decays liberating its constituents in forms available for plant nutrition. It is quite unnecessary to compost it, though little loss would ensue if composting with muck or other vegetable matter which would absorb and hold the decomposition products is resorted to, provided the heap is not exposed to heavy leaching rains. The weathering of seaweed alone is a wasteful process. On the whole, the best plan is to apply the seaweed direct to the soil, with which it will readily become incorporated. It is essentially of the nature of a quickly acting, forcing manure.

Seaweed can be employed for all classes of crops, though it will be found most useful for roots, vegetables and those with an abundance of foliage, since it is essentially a nitrogenous and potassic manure. It has given excellent results as a top dressing for grass lands, encouraging the growth of clover more particularly. Its composition suggests that if a more complete fertilizer is desired it should be supplemented by superphosphate, basic slag or bone meal. Seaweed gives its best returns on moderately light loams that are warm and moist and its poorest on wet, ill-drained, heavy clays.

DRIED, GROUND SEAWEED.

It would seem possible to dry and grind the seaweed at some point near its collection and thus prepare from this naturally-occurring fertilizer a material convenient for application to the land and sufficiently rich in plant food to allow of inland transportation. The writer analysed such a material three years ago. It had been prepared in Nova Scotia from rockweed (*Fucus furcatus*), a gentle heat being used in the drying. It was a coarse, dark green powder, one which might readily be broadcasted or applied by the fertilizer attachment of the seed drill. The analysis furnished the following data:—

Water.. . . .	9.48
Organic matter.. . . .	72.61
Ash or mineral matter.. . . .	17.91
	100.00
Nitrogen.. . . .	1.32
Phosphoric acid.. . . .	.29
Potash.. . . .	2.26

These data are in fair accord with those obtained from the analysis of fresh rockweed, calculated to the same moisture content as the sample examined and we may conclude, therefore, that there had been no appreciable losses in the plant food constituents during the drying of the weed. We do not think that the drying brought about any marked impairment in availability.

Inquiries as to the possibility of preparing this seaweed powder on a commercial scale elicit the information that attempts have been frequently made in Europe to prepare an easily handled, concentrated fertilizer from seaweed, but that so far the mechanical and other difficulties in drying and grinding, largely consequent upon

the mucilaginous character of the seaweed, have been such as to prevent the manufacture being carried on profitably. These difficulties, however, we cannot think are insuperable, and certainly the present times would encourage further trials in this direction.

LIBERATORS OF POTASH.

There is no substitute for potash in agriculture; it cannot be replaced in the plant's economy by soda or any other compound. But there are certain substances that act as excitants or liberators of the locked-up, inert stores of potash in the soil and thus may be considered as indirect potash fertilizers. We shall discuss briefly two of these: gypsum and nitrate of soda.

Gypsum, commonly known in the ground form as land plaster, is a naturally occurring sulphate of lime. Although supplying lime it is of no value for the correction of acidity (sourness) of soils, for which purpose lime or ground limestone must be employed. But the furnishing of lime does not constitute its chief manurial value. It has the property of acting on the insoluble potassic compounds of the soil, setting free for plant use a part of their potash. This is its most important function and it is this property that has made it specially beneficial as a top dressing for clover, a crop that particularly responds to potash. The application of land plaster is usually from 300 to 600 pounds per acre, which may be broadcasted on the prepared land and harrowed in.

Large deposits of gypsum occur in New Brunswick, Nova Scotia and Ontario and as it is readily quarried and is comparatively soft material, land plaster may be purchased cheaply—in many districts at a lower price than ground limestone.

Users of superphosphate (acid phosphate) will have no necessity to apply land plaster since this phosphatic fertilizer contains sulphate of lime as a necessary constituent.

Nitrate of soda is a well known, highly efficient nitrogenous fertilizer. It has been shown that crops "feeding upon a neutral salt like nitrate of soda, take up more of the nitric acid than of the soda." This soda acts chemically upon the stores of insoluble potash compounds setting free a certain amount of potash and thus rendering it unnecessary, in a certain measure, to directly apply a potassic fertilizer. It is this liberation of soda within the soil that is the cause of the deleterious action on the tilth or texture of heavy clay loams when large and frequently repeated applications of nitrate of soda are made, for soda has the property of deflocculating clays, making them sticky when wet and refractory when dry. We should not advise any special application of nitrate of soda to make up for the lack of a potash fertilizer, but it is obvious from what has been stated that its use to a certain degree obviates the necessity of such an application, especially on heavy loams.

CONCLUSIONS.

It is our light, sandy and gravelly soils that are markedly deficient in potash and this element is only specially called for by clover, potatoes, roots and leafy crops generally.

There is yet some potash in the market though it will probably have to be purchased in the form of a complete fertilizer.

We have several Canadian sources of potash available to the farmer—notably liquid manure, wood ashes and seaweed—materials rich in this useful constituent and which are more or less readily obtainable in many parts of the Dominion.

And lastly there are the indirect potassic fertilizers, which though not adding to the sum total of the soil's potash yet may serve a useful purpose by liberating it in available forms and thus in times such as the present may help to tide us over until potash compounds are once more upon the market.

